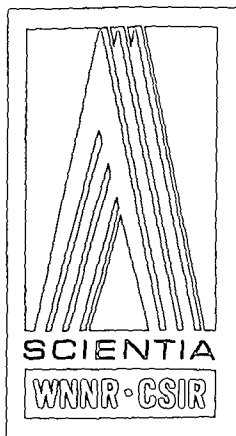


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TO ASSESS THE VALUE OF SATELLITE IMAGERY IN  
RESOURCE EVALUATION ON A NATIONAL SCALE

August 1973

Type II Report for Period Feb 1973 to July 1973

DR O. G. MALAN

NATIONAL PHYSICAL RESEARCH LABORATORY  
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Mr W. Kirchhoff	Aircraft Operating Co. (Pty) Ltd											
15. Abstract  This report continues the analysis of ERTS-1 imagery of South Africa (see NASA-CR-130012). Production of 1:500 000 scale false colour photolithoprints proved to be very valuable. Significant results were obtained in geomorphological mapping, mapping of disturbed and undisturbed natural vegetation as well as in the discovery of major geologic lineaments, some of which may be associated with mineralization. The cartographic quality of system corrected MSS imagery was also evaluated.												

P R E F A C E

This report is a continuation of report FIS-38, the Type II report for the period July 1972 to January 1973.

It is divided into six sections:

Section I deals with problems with data quality and describes the method of production of the 1:500 000 false colour lithoprints which will be produced to give national coverage.

Section II describes somewhat negative results with soil and erosion mapping as well as more promising results with geomorphological mapping.

Section III deals with plant ecological mapping in the South Western Transvaal, Eastern Transvaal Escarpment, Northern Transvaal Bushveld and the Eastern Cape. A continued evaluation of mapping of degraded ecological type is described <sup>well as</sup> as an attempt to map kelp beds.

Section IV describes the geological analysis of ERTS-1 imagery of the Transvaal and Natal.

Section V explains a cooperative programme with South African universities and the Natal Provincial Administration for regional land use surveys and finally

Section VI gives a cartographic evaluation of system corrected MSS imagery

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SUMMARY OF SIGNIFICANT RESULTSDISCIPLINE 10AIMAGE REPRODUCTION: DISCIPLINE 8E

Five scenes have been reproduced as 1:500 000 scale false colour photolitho prints. Analysis of these have proved to be so much simpler and to produce so much additional information that total national coverage will be produced in this form.

Some of the negative conclusions drawn on the basis of 1:10<sup>6</sup> scale black and white prints had to be reviewed when the 1:500 000 scale prints became available.

SOIL AND TERRAIN MAPPING: DISCIPLINE 1D

Soil mapping proved to be less successful than expected. Nevertheless the Makatini/Shortland soils could be distinguished from very sandy soils. Sandy soils and lithosoils in the north-western Free State, black clay soils in the northern Free State and south-eastern Transvaal could be identified.

Erosion mapping proved to be unsuccessful.

It was possible to distinguish cultivated land, natural grazing land and irrigation schemes but not possible to subdivide further.

In small scale geomorphological mapping the application of ERTS imagery proved to be fairly promising in dry areas, whereas it seemed less valuable in areas with a humid climate.

PLANT ECOLOGICAL SURVEYS: DISCIPLINE 1C

The conclusions drawn in the previous report have been substantiated.

In many cases ecological types can be mapped with greater ease, much faster, more accurately and at lower cost than by conventional methods.

In particular forest, woodland and scrubforest can easily be distinguished from grassland, parkland and savanna and under certain circumstances even the above physiogromic types can be distinguished as well as different grassland types.

Of major interest is the manner in which cultivated areas, mismanaged areas, degraded and invasive vegetation types and burnt areas can be distinguished.

The mapping of kelp has not been successful.

GEOLOGY: DISCIPLINE 3K

ERTS imagery reveals large structural features more clearly and with less effort than by conventional means.

Besides clearly revealing known structures such as the Bushveld complex, the Pilanesberg alkaline complex, the Ventersdorp lava, the Lebombo monocline, and a swarm of diabase dykes between Pongola and Piet Retief, some important previously unknown features were discovered:

- (1) A major lineament, coinciding with known faults, which runs for almost 600 km from Swaziland through the Bushveld Complex into Botswana. This lineament also bounds the Barberton Mountainland, the triangular patch of felsite in Waterberg sandstone and cuts through the alkaline rocks near Badplaats as well as the carbonatite at Glendover.
- (2) The NW trending faults in the western Bushveld continue much further than previously known and a number of pipe like bodies lie on these lineaments. A number of NE trending lineaments were also discovered in this area, their direction coinciding with some kimberlite fissures north of Swartruggens.
- (3) A faint NE lineament coinciding with copper and gold deposits at the Harlequin Mine, the minor copper deposits at Bandelierkop. This may represent a mineralized shear or fracture zone.
- (4) A lineament, some 80 km long running NW between Paulpietersburg and Piet Retief.

CARTOGRAPHY: DISCIPLINE 2B

A cartographic study based on identification of known detail points revealed a scale discrepancy of nearly .5%, a displacement of up to 5 km in latitude and a displacement of up to 3.5 km in longitude of the geographic tick marks on system corrected MSS imagery. These variations also include an azimuth swing of 2 degrees.

After correction of these errors, all measured points were within 500 m of their true positions.

## I. GENERAL

### 1. PERSONNEL CHANGES

Dr J.M. de Villiers, co-investigator for Soil and Terrain Mapping has left the Soil and Irrigation Research Institute. Dr C.N. MacVicar, his successor, will act as co-investigator in future.

Mr L. Claassen, Department of Planning and the Environment, previously assistant investigator, replaces Mr J.J. la Grange as co-investigator for Land Use Survey.

### 2. DATA RECEIVED AND COVERAGE

To the end of the report period about 500 scenes, mainly all four bands of MSS, were received. Every part of the Republic of South Africa has been covered at least once with more than 97 % of this area completely cloud free. Most scenes have been covered repetitively - some up to seven times.

### 3. DATA QUALITY

Most 70 mm negatives and positives received were of excellent quality. Unfortunately data in which the quality was degraded were also received.

Newton rings, which appeared fairly regularly during initial consignments, were completely absent during the latest shipments.

Flaws caused by lint, fibres, etc. still regularly appear on 70 mm products. These seem to be situated in the reproduction apparatus since they usually reappear at different positions on all four bands of a particular scene. Fortunately these flaws usually do not interfere seriously with the interpretation of the data.

The most troublesome defect in the 70 mm photographic products received is the fact definition was lost due to unsharpness, presumably in the photographic reproduction process. This can readily be observed by inspecting the diagonals of the alphanumeric symbols  $\phi$ , N, Z, 2, etc. in the image annotation or geographic tick marks. In sharply reproduced images the steps in the diagonal - including the consistent error near the base of the symbol N- are sharply defined. Some products received were uniformly unsharp and in many others the annotation quality varied from sharp to unsharp over the image (unsharp-

ness was observed to be distributed randomly and not restricted to corners or edges).

Assuming that the transfer characteristics from EBR onto the first generation positive is constant, the definition of the alphanumeric symbols gives a convenient criterium for the quality of the photographic processing process, independent of scene, data acquisition or data transmission characteristics. For this purpose additional special resolution test patterns, generated by the EBR and inserted between tick marks on the image border, might be useful - also in subsequent photographic reproduction by users.

#### 4. REPRODUCTION OF IMAGERY

Experimental false colour photolitho prints of ERTS Images were reproduced to a scale of about 1:500 000:

For this purpose 70 mm positives supplied by NASA were initially employed. In a single step these were reproduced as a negative screen to a scale of 1:500 000. Simultaneously the contrast was also increased by processing step 5 and step 14 respectively to 0 % and 100 % transmission (in the negative screen). Densitometry on a few selected scenes have indicated that very little information is lost by sacrificing the extreme ends of the grey scale in favour of increased contrast.

MSS bands 4, 5 and 7 were then printed in a set of trichromatic colours, respectively yellow, magenta and cyan.

A set of three scenes: 1084-07265, 1049-07295 and 1180-08015 reproduced by means of screens with respectively 133, 150 and 175 screen points per inch are appended to this report. Scene 1180-08015, therefore, consists of about 6.5 million screen points per colour compared with 7.5 million theoretical data points.

It is clear, however, particularly in this scene, that the final resolution is determined to a greater extent by the quality of the 70 mm originals than by the number of screen points.

For this reason 9" positives, whose quality is significantly better than most 70 mm products, were ordered from NPDP for the production of a set of about 80 scenes, giving complete coverage of the Republic of South Africa and including Lesotho and Swaziland, during the next few months.

The cost of this venture will be borne by subscriptions from mining and exploration companies, universities, government departments, etc.

These 1:500 000 scale false colour images will be utilized for future analysis in this proposal and might necessitate revision of some of the negative conclusions based on 1:10<sup>6</sup> scale black and white prints during the past.

#### 5. RECOMMENDATIONS

1. Stringent precautions should be taken to eliminate the degradation in resolution during photographic reproduction at NDPF. The most sought after improvement in ERTS imagery is probably increased resolution and that provided by the technological advanced data acquisition and transmission system should be preserved in photographic reproduction process at all cost. For this purpose the addition of resolution test patterns on imagery may be useful.
2. Care should be taken to avoid flaws in imagery, presumeably caused by dust fibres, lint, etc. in the reproduction apparatus.
3. The substitution of alternate linear transmission grey scales by linear optical density grey scales and reproduction of these above and below images, is recommended.

## II. EVALUATION OF ERTS-1 IMAGERY FOR SMALL SCALE SOIL AND TERRAIN MAPPING AND INVENTORIZATION

Co-investigator : Dr C.N. MacVicar

Assistant Investigators: Mr G.P. Kruger  
Mr R.W. Bruce  
Mr J.F. Eloff  
Mr J.L. Schoeman  
Mr P.A.E. McGee

Soil and Irrigation Research Institute  
Dept of Agricultural Technical Services  
Pretoria

### 1. OBJECTIVES

The object of the project is to evaluate the application of earth satellite imagery to small-scale soil and terrain mapping.

### 2. ANALYSIS TECHNIQUES

The general procedure followed by the field staff involved in this investigation, was the viewing of 1:10<sup>6</sup> scale black and white images with the aid of a hand lens or stereoscope. The first phase of the investigation was aimed at the delimitation of patterns. The second phase consisted of the identification of individual characteristics within these patterns.

No further investigations with black and white images will be carried out for the next report. Time permitting, there is a possibility that the above areas may again be investigated at some later date with the aid of 1:500 000 photolitho prints.

### 3. RESULTS

The following images were investigated by the field staff to try and assess their value in the study of soil and erosion, as well as agricultural land use:

1050/07364

1069/07423

1069/07414

1050/07355

1049/07304

1048/07245

1049/07313

1047/07191

### 3.1 Soil Mapping

The general trend of the reports submitted by the field personnel varies from negative to neutral.

It is clear however that identification of soil types is possible only where a close correlation exists between soil type, vegetation terrain morphology, geology or land use.

On the Makatini plain in north eastern Natal it was possible, for example, to distinguish between soils of the Makatini/Shortlands association, which is under a bushveld-savanna vegetation and very sandy soils covered by forests. In the north-western Orange Free State it was possible to identify sandy soils on account of the light shade of ploughed lands. Lithosols associated with mountainous and hilly land could be identified where the mountains hills were clearly perceptible.

Black clay soils of the northern Orange Free State and south eastern Transvaal are shown by the darker shade of ploughed lands. In the rest of the areas investigated, the images contributed little to efficient mapping of soil regions.

No correlation of any importance could be observed between the patterns supplied by the imagery and existing soil maps at the same scale.

### 3.2 Erosion

It was impossible to delimitate areas with widespread erosion. The reason for this may be the fact that these are found mainly in narrow strips along rivers and that their tone and texture are very similar to that of the deposits in which they occur.

### 3.3 Agricultural Land Use

It was possible to distinguish cultivated land, natural grazing land and irrigation schemes, but not possible to subdivide further.

Areas under dryland cultivation have a characteristic chequerboard pattern, and the intensity of use can be gathered from the general size of the squares.

Grazing areas contain few features caused by human exploitation with the result that it has a more natural pattern with gradual transitions.

Areas under irrigation can easily be identified by the small chequerboard pattern and their position.

### 3.4 Geomorphology

A preliminary geomorphological interpretation of the satellite images listed below was completed (part of the area is given in Fig. 1):

1056/08111	1053/07533
1056/08114	1075/07540
1145/08061	1053/07542
1055/08035	1053/07545
1055/08041	1052/07472
1055/08044	1052/07475
1055/08050	1142/07484
1055/08053	1142/07490
1055/08055	1142/07493
1055/08062	1142/07595
1055/08064	1142/07502
1055/08071	1142/07504
1072/07585	1141/07432
1072/07592	1141/07435
1125/07533	1141/07441
1053/07531	

A field reconnaissance trip was undertaken to control the boundaries determined in the office.

Further geomorphological research of previously mentioned images is planned during the next reporting period. An investigation of the following images is also envisaged:

1180/08001  
 1180/08003  
 1180/08010  
 1180/08012  
 1180/08015  
 1198/08000  
 1198/08003

The boundaries of each broad terrain pattern are clear as long as there is a marked contrast with the adjoining pattern. It was observed that the boundaries tend to become indistinct as the climate becomes

A RECONNAISSANCE GENERAL GEOMORPHOLOGICAL MAP OF THE WESTERN BUSHMANLAND AND NAMAQUALAND

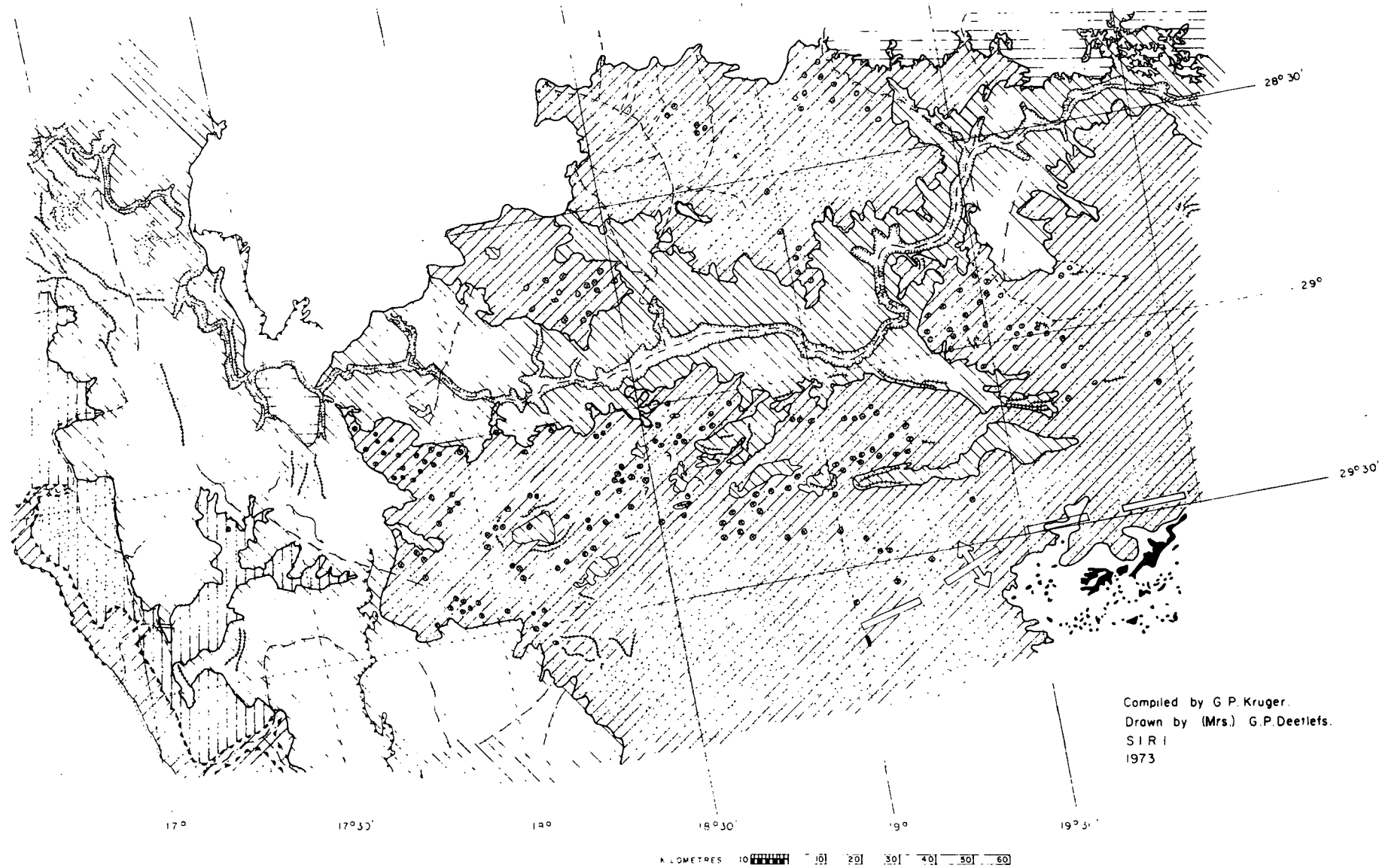


FIGURE 1

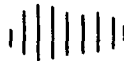
## GEOMORPHOLOGICAL MAP LEGEND

A. FORM COMPLEXES (RELIEF CLASSES)

Flat low lands



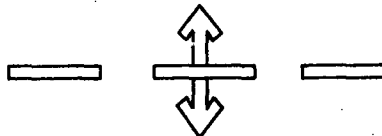
Undulating low lands



Hilly and mountainous areas

B. SPECIAL RELIEF FORMS

(1) Neotectonic cymatogenic anticlinal axis



(2) Joints

(3) Fragments of destructional land surfaces  
(Plateaus etc.)

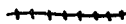
(4) Isolated residuals (monadnock, butte)



(5) Cuestas



(6) Hogbacks

(7) Ridges resulting from the intersection of  
valley slopes

(8) Edges of deep incised valleys and canyons



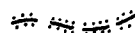
(9) Large waterfalls



(10) River channel



(11) Large accumulation flood plains and terraces



(12) Deflation depressions (Pans, Playas)



(13) Areas of drift sand



(14) Areas of transversal dunes



(15) Abrasion cliffs in rock



(16) Older abrasion cliffs in rock



(17) Beaches



humid. The sharpest and clearest boundaries between patterns and individual components of a pattern were observed in semi-arid and arid areas.

Mountainous areas and plains were recognised easily. Foothills were often confused with piedmont plains.

Large flat low lands, which display a fine texture and a light tone on the images, form a considerable part of the area. In some instances these low lands are featureless while in other cases they are dotted by isolated residuals. These residuals are easily identified on the satellite images because of the darker tone. Pans and playas are easily identified as long as they are situated against a darker background. The pans and playas in this area form a zone, and the origin is closely linked to a neotectonic cymatogenic anticlinal axis which is encountered to the north of the pan and the playa zone.

The boundaries between the Bushmanland drift sands and this pan veld to its south, could be clearly distinguished. It was more difficult to determine the boundary between the pan veld and the adjoining area to the south, which mainly covers strata of the Beaufort Series. Hilly and mountainous areas are typically coarse textured with a dark tone in most cases. The position and morphology of these landforms can be ascribed largely to the underlying geological structure. The cuesta, for instance, north of the Orange River in the vicinity of the Augrabies Falls (North Eastern corner of map) is the result of resistant, horizontal layers of the Nama System. The genesis and evolution of mountains and hills consisting of granite in the mapped area is closely correlated with the occurrence of joints.

Some mountains and hills in the vicinity of the lower Orange River are the result of resistant rocks in the Kheis System. The tertiary marine surfaces on the west and south coasts were identified without difficulty because of their characteristic morphology.

The areas folded by the Cape orogeny could be separated easily from the rest of the area investigated.

The components of an area vary greatly in perceptibility. The general tendency in the area is that all alluvial, aeolean sands and colluvial deposits have a very light shade. Dolerite outcrops are very dark and the other rocks vary in shade between these two extremes.

Crest, dolerite ridges, colluvial footslopes, pans and flood plains could be identified easily. The edge of the Great Escarpment near Sutherland is extremely well-defined.

Some dunes are not always distinguishable. In the Koa Valley two areas covered by transverse river sand dunes can be seen on the satellite images. It is however not possible to identify the bulk of the sand dunes in this area. The same problem is experienced in the northern parts of the Kalahari Gemsbok National Park. The sand dunes in this area are probably concealed by vegetation.

The fluvial activities in the mountainous areas (especially to the west) led to the formation of narrow, steepside valleys, the direction and position which are largely influenced by joint systems. The flood plains of most of the river systems are covered by recent alluvium which can be identified here and there on the images.

#### 4. CONCLUSIONS

1. The personnel concerned could not have mapped soil associations with greater speed and accuracy than with the aid of conventional methods.
2. In the case of soil mapping these images contribute very little new information as the differences they show are already known. In a few isolated areas, where no information was available, the images were useful. This conclusion is based on information obtained from 1:1 000 000 black and white images. It is possible, however, that 1:500 000 false colour litho prints may be of greater assistance although preliminary investigations with false colour images did not produce significant results.
3. The value of the images for soil mapping is possibly the fact that it makes one aware of differences in certain areas.
4. The possibilities for geomorphological mapping of small scale are generally fairly promising, depending on the terrain. In humid regions the images are of limited value for this purpose.
5. Satellite imagery seems to have little cost benefit. This can be accounted for by the fact that the images can only play a minor role in the type of surveys undertaken. This is especially true in the case of soil association mapping. It is more useful for small scale geomorphological mapping.

### III. PLANT ECOLOGICAL SURVEYS

Co-investigator : Dr D. Edwards

Assistent Investigator: Mr J.W. Morris  
 Botanical Research Institute  
 Department of Agricultural Technical  
 Services  
 Pretoria

#### A. LAND USE AND VEGETATIONAL PATTERNS IN THE SOUTH WESTERN TRANSVAAL

##### 1. OBJECTIVES

To identify and map the major ecological and vegetational interfaces from ERTS imagery.

##### 2. ACCOMPLISHMENTS

Ten days were spent in the area covered by the photographs and a distance of over 3000 Km was covered. Scenes, 1068-07355, 1068-07362, 1069-07414 and 1069-07420 in Band 7 MSS, only, were investigated. Most of the observable interfaces were studied in the field.

It is proposed to compare these winter scenes with ones taken at other seasons and to map the observable boundaries at a scale of 1:500 000.

##### 3. RECOMMENDATIONS

Litho prints of ERTS imagery at a scale of 1:500 000 have been experimentally produced for certain key areas and will greatly improve interpretability and aid mapping if made available for this area.

##### 4. CONCLUSIONS

###### 4.1 Vegetation

Most of the Veld Types described by Acocks (1953) were clearly recognisable on the imagery. In particular, the boundary between Bankenveld and Cymbopogon-Themeda Veld in the area near Lichtenburg was most distinct. From the scenes it will be possible to map their boundary much more accurately than done by Acocks and, in fact, the shape of the actual Bankenveld band will change quite markedly.

The boundaries between Cymbopogon-Themeda Veld and Sourish Mixed Bushveld in the west, between Cymbopogon-Themeda Veld and Bankenveld in the east and between Cymbopogon-Themeda Veld and Kalahari Thornveld in the south were clearly visible. A boundary near Bloemhof in the south of the study area between a western and an eastern form of the Kalahari Thornveld was observed on the image but has still to be investigated on the ground.

As the map drawn by Acocks has been a basis for all agricultural land use planning during the past twenty years, an accurate version now possible with ERTS imagery, will be of inestimable value to agricultural economic planners.

The Vaal-Hartz Irrigation Scheme in the south-west corner of the study area was clearly visible.

#### 4.2 Geomorphology

The linear arrangement of pans (= temporal lakes in America) which, it has been suggested, mark the courses of fossil rivers, are clearly visible. This phenomenon may be of great use to geographers and geomorphologists and requires more investigation.

#### 4.3 Fire

Areas which had been burnt were clearly visible on the photographs, but in some cases were difficult to locate on the ground as there had been a very good recovery of the vegetation following good but late rains. Six months separated the satellite orbit and my visit to the area. One large fire between Mafeking and Zeerust was attributed to coal-burning steam engines. These machines are not used on any other route in the area.

#### 5. FUTURE WORK

Further research will be carried out on photolithoprints which should become available in September 1973.

#### B. THE IDENTIFICATION AND MAPPING OF EXTENSIVE SECONDARY INVASIVE AND DEGRADED ECOLOGICAL TYPES

Assistant Investigators: N. Jarman and O. Bosch

### 1. OBJECTIVES

To attempt to recognise areas which have been degraded over the last twenty years by comparing ERTS imagery with Acock's Veld Types of South Africa (1953).\*

### 2. SUMMARY OF ACCOMPLISHMENTS

The boundary of the degraded area as delimited in our previous report (S.R. 9616 - Feb. 1973 P. 27) was checked in the field and found generally to be accurate, although some alterations had to be made due to errors in interpretation, the result of inexperience.

Correspondence between the assistant investigators and Mr Acocks is at present in progress to arrange for publication.

Although successfully completed, 1:500 000 scale imagery may have increased accuracy.

### 3. CONCLUSIONS

In 1953 Acocks<sup>\*</sup> stressed that dwarf shrub communities of the False Upper Karroo were invading pure grassland. Now twenty years later, with the ERTS imagery (1049-07313) it has been possible to measure how far the invasion has actually advanced.

After field-work and interpretation of the imagery a conservative measurement of the invasion is 43 Km over a large front.

Although agriculturalists were aware of this vegetation change the ERTS imagery has high-lighted the seriousness of the problem.

An evaluation of revenue lost and the amount of money it will cost to prevent encroachment cannot be readily estimated but if degradation carries on at its rate the revenue loss will be maximal.

It is only from a synoptic view of these threatened areas as given by ERTS that the vegetation patterns can be readily observed and brought to the notice of Agricultural Planners.

### 4. DEVELOPMENTS AS A RESULT OF THIS RESEARCH

This research has been reviewed by a number of research workers and the popular press. There is some disagreement over the exact boundary drawn although the invasionary trend is agreed by all. This problem will be settled with the completion of a thesis by O. Bosch.

\*Acocks, J.P.H. 1953 Veld Types of South Africa. Mem.Bot.Surv.S.Afr 28 1-192

C. INVESTIGATION OF APPLICABILITY OF SATELLITE IMAGERY  
TO VEGETATION MAPPING AT 1:1 000 000 SCALE IN THE  
EASTERN-TRANSVAAL ESCARPMENT AREA

Assistant Investigator: J.C. Scheepers

1. OBJECTIVE

The usefulness of satellite imagery as an aid in a minor project (already under way) to be assessed during a reconnaissance field trip.

2. SUMMARY OF ACCOMPLISHMENTS

A short field trip was undertaken in the beginning of April 1973 to investigate the possibilities of distinguishing physiognomic vegetation classes on satellite imagery.

One of the major problems encountered was that of orientation. It was found very difficult to establish the precise location of points on the satellite photo with localities in the field. This, however, can be overcome by more detailed preparation.

Forest stands can be separated from timber plantations largely by inference. The distinction between forest, woodland and 'scrubforest' is not easy without more elaborate and sophisticated preparation. The above physiognomic vegetation classes can be distinguished from grassland parkland and savanna. Grassland, parkland and savanna were not individually distinguishable on the satellite photos although strikingly different in the field. More sophisticated techniques will be required here.

ID numbers of scenes used were 1047-07175, 1047-07182 and 1047-07184, MSS bands 5 and 7.

3. CONCLUSIONS

Mapping the distribution of forest and plantation can be carried out rapidly without extensive and expensive field-work. This can be useful in mapping natural resources. If techniques for distinguishing grassland, parkland and savanna can be discovered, mapping of physiognomic vegetation-classes will be greatly facilitated. More work needs to be done on these problems.

D. EVALUATION OF ERTS-1 DATA FOR A PLANT  
ECOLOGICAL SURVEY OF THE NORTHERN  
TRANSVAAAL BUSHVELD

Assistant Investigator: B.J. Coetzee

1. OBJECTIVE

To use ERTS-1 imagery for a reconnaissance botanical survey (scale 1:250 000).

2. SUMMARY OF ACCOMPLISHMENTS

An experimental transect of aerial photographs from Derby, over Rustenburg, to Vaalwater has been flown by the South African Air Force at scales of 1:50 000 and 1:150 000 using infra-red colour film. These photographs were studied to determine their use in interpreting the ERTS-photos, scene 1050-07355. Further field-work was done in a 2800 ha ground truth area within the transect, on the Magaliesberg near Rustenburg, to obtain more detailed information on soils and vegetation. The intention is to start mapping vegetation at 1:250 000 in a pilot area to test methods and aids further.

3. PROBLEMS

The major problems encountered were:

- (i) The scale of the prints used (1:1 000 000) was not entirely suitable for mapping purposes.
- (ii) The images obtained by the additive colour viewer were preferred to black and white prints but large scale reproductions of the colour images are needed to take into the field for mapping purposes.
- (iii) Time of photography was unfavourable for vegetation studies.

4. RECOMMENDATIONS

Large scale (1:250 000) lithographic prints should be made available and autumn imagery be obtained before the vegetation acquires its monochrome winter colour and veld fires remove any trace of species composition variation.

The experimental lithographic prints were found to be ideally suited to mapping purposes and ease of handling in the field. It is recommended that these be made available for the whole of Test Site A at a 1:250 000 scale. Scene 1085-07303 used.

## 5. CONCLUSIONS

With the aid of 1:150 000 scale infra-red colour transparencies it was found that physiognomic types such as savanna and grassland could sometimes be separated, though ERTS photos could not, so far, be used to separate these types with any confidence. However, major physiognomic types such as forest, scrub and grassland could be confidently recognised.

Of major interest was the manner in which the overgrazed areas of the veld were obvious. This is due to the soil colour showing through where the vegetation has been partially denuded. These 'disturbed' areas are of great importance in the attempt by Agricultural Technical Services to curb soil erosion.

## 6. FUTURE WORK

This investigation will be continued as soon as improved 1:500 000 scale photolithoprints of the area become available.

## E. AN INVESTIGATION INTO THE POSITION OF THE EVERGREEN FORESTS AND OTHER VEGETATION OF THE EASTERN CAPE

Assistant Investigator: N.G. Jarman

### 1. OBJECTIVES

- (a) To investigate the potential of false colour photolitho prints of ERTS-1 imagery at a scale of 1:500 000 for vegetation mapping.
- (b) To establish the position and boundaries of evergreen forests in a portion of the Eastern Cape Region of South Africa.

### 2. METHOD

The scene 1084-07265 taken on 15 October 1972 in the form of a 1:500 000 scale false colour photolitho print of MSS bands 4, 5 and 7 was examined.

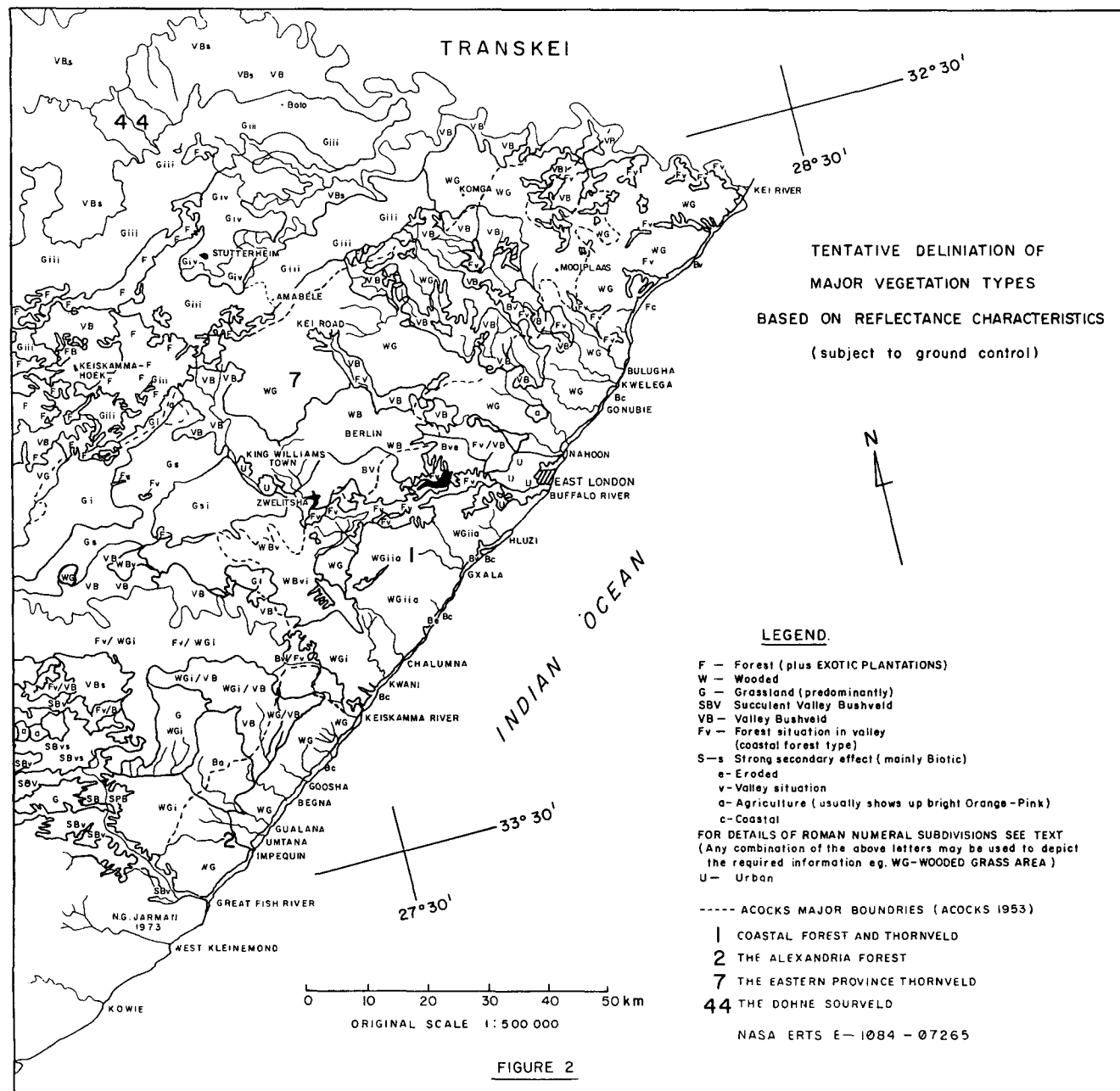
By investigating a number of truth sites within the total image area during a field trip, certain trends in the vegetation could be established. This was done on the hue, texture, shape and size of the various units recognised. These units are then justified on the grounds of present and past knowledge of the physiography, vegetation, landuse and demographic patterns. Much of the information on the natural environment and landuse in the Eastern Cape is derived from Board et al. (1962).

### 3. BACKGROUND

The strongest red tone is from the vegetation. The more dense the vegetation, the more saturated the red hue (Blythe & Kurath, 1968). Forests and thick bush with heavy canopies show up in deep red hues, savannas which have an open tree canopy show up in deep red hues, savannas which have an open tree canopy show up slightly less red, while grassland is depicted as a pale yellow/orange.

The area covered, a portion of the coast around East London, has been divided by Acocks (1953) into a number of different major vegetation types, delineated on Fig. 2 by dotted lines:

- (a) On and immediately behind the coastal sand dunes, is a coast dune scrub and forest vegetation with a smooth, salt and wind pruned canopy, which shows up on the lithoprint as a thin dark red line along the coast, enlarging into patches where undisturbed.
- (b) In the east, running parallel to the coast, is a 25 km wide vegetation belt rising to the 500 m contour which is termed the 'Coast Forest and Thornveld' (Acocks Veld Type 1) characterised by relic forests in protected areas, such as river valleys, separated by grassed areas on the interfluves which have a strong woody element and which, if completely protected, revert rapidly to forest. This type can be recognised by a slightly more pink tinge.
- (c) Between the 500 m and 700 m contour is an undulating plain, approximately 35 Km wide, termed the 'Eastern Province Thornveld'. This area supports an Acacia karroo/grass vegetation with a complete physiognomic



range from closed Acacia karroo tree and shrub communities, through more open types to pure grass in the King Williams Town area. On the imagery one can detect a tendency for Acacia karroo trees to dominate in the north-eastern portion of the photo as shown by the deeper pink while more open communities tend to dominate in the south-west.

- (d) Above the 700 m contour lies Acocks 'Dohne Sourveld' (Acocks Veld type 44b) with a cooler climate than the previous types and supporting extensive forests, tree plantations and grassed areas. The bright red of the forests are the most noticeable vegetational features on the lithoprint. The accompanying grassland with good cover, which is generally well conserved, is also clearly distinguishable from the wooded communities.

These four major vegetation belts are dissected by incised valleys formed by rivers such as the Buffalo, Keiskamma, Chalamna and Kei. These valleys receive a less effective rainfall than the surrounding ridges and plains and have a bush vegetation characterised by many thorny scramblers and a less dense field layer. The north-facing slopes carry xeric plant communities while some of the south-facing slopes support a mesic vegetation or even develop narrow strips of short dense 'forest'. These small forest patches with bush margins can be easily picked out by their dark red colour although, so small that accurate mapping of their boundaries is impossible.

The vegetation in this area has been profoundly modified by man, firstly by the Bantu pastoralists and, to a greater extent, by the more-intensive exploitation by Bantu and Whites.

#### 4. RESULTS, VEGETATION AND LAND USE

##### 4.1 Area Between the Keiskamma and Buffalo

###### 4.1.1 The Coastal Region

(i.e. 'Coast Forest and Thornveld' Acocks, (1953)).

###### The Beaches and Estuaries

The sandy beaches, in places up to 3 km wide, run the entire length of the coastline, being broken only by river mouths and occasional rocky stretches.

The river mouths tend to widen into estuaries, as is well demonstrated by the Buffalo, Keiskamma and Gonubie Rivers.

#### Coast Dune Scrub and Forest (Bc)

This vegetation type lies on and behind the dunes but seldom reaches a width of more than 500 m, except where specially protected. It runs the entire length of the coast being broken only by rivers and urban development. Most of the vegetation is a dense shrub type, but in some areas its successional development may reach the forest climax, though this has largely disappeared as a result of exploitation clearing. The deep red signature from this type indicates the dense nature of the canopy and is denoted by Bc or Coastal Bush in the annotation.

#### Coast Forest and Thornveld (WGi and WGii)

In an area between the Keiskamma and the Buffalo Rivers in a belt approximately 15 km wide, lies an important agricultural area, with a natural vegetation of grass and small trees, usually Acacia karroo. The physiognomic status of this type varies from thorn woodland (closed trees) through thorn savannas (trees open) to grassland (trees absent). This area is characterised by a reddish hue on the image suggesting that trees are generally present though not providing a completely closed area. There are certain pattern differences between WGi and WGii, although they are classed here together. This difference is caused by a land use pattern; WGi is a Bantu area under a strict betterment management programme (Board, 1962) with limited agriculture to prevent erosion, while WGii is a White area with more agricultural diversity. In this area the light pink areas show the areas of cultivation, probably pineapples.

In many protected valleys there are signs of forest developing which may readily be picked out by their definite red hue.

The northern boundary of this type may be taken as the Buffalo River where there is a hue change to a slightly darker red at this point.

#### 4.1.2 Eastern Province Thornveld (WBvi)

To the west, of the Coast Forest and Thornveld above 500 m, is a physiographically separated area showing marked topographic dissection. In the river valleys, which will be discussed later, a similar pattern can be found and one expects a thorny vegetation type now dominated by

Acacia karroo, but probably grassy in former times. Along with the undulating texture of the image there is a slightly darker red hue which suggests the presence of woody species. This area contrasts with the adjacent type, a grassed area, Gi, which has a smooth texture and an orange-red hue, suggesting a good vegetation cover apart from some areas where agriculture has been practised and the field boundaries are obvious. The adjacent grassed area, Gi, appears to be similar in all respects, but the land use pattern where there is heavy grazing suspected becomes a grey orange, contrasted to the orange hue of the first grassed area.

#### 4.1.3 Dohne Highland Sourveld (F and Giii)

This area, as the title suggests, is higher (over 700 m elevation) than the other areas so far discussed and as a result is cooler with a higher rainfall. This climate is capable of supporting an evergreen forest climax (F). In many areas the climax is realised, but where environmental and biotic factors prevent this a good cover of grass is usually present (Giii).

#### 4.1.4 Valley Bushveld and Coast Lowlands Forests (VB and Fv)

The rivers in and bounding the Keiskamma-Buffalo Rivers, have steep valleys which are considered here to have two phases of a vegetation type Acocks (1953) refers to as Valley Bushveld. On mesic slopes a dense tree or shrub vegetation is evident from the red colour associated with it. This vegetation may develop into a very dense often succulent bush with a solid green canopy. If the site situation is mesic and protected, forest will often develop. Many of these forest and dense bush patches can be clearly seen as dark red on the photolithoprints, but because of their small size they have not been annotated. On the xeric slopes, a drier microphyllous vegetation predominates, often associated on the photolithoprint with a grey-blue colour, of trees, usually Acacia spp., with a grassed ground layer where not removed by man. This phase of the Valley Bushveld is very well adapted to the climate in this area, and if correct management is not applied on the grassy interfluvies the bush rapidly invades the grassed areas.

#### 4.2 The Area Between the Buffalo and Kei Rivers

This area is dissected by a number of rivers, as can be seen on the imagery. This dissection has resulted in a complex geomorphological pattern that in turn supports a very varied vegetation, which has been modified over the past 800 years by biotic influences.

##### 4.2.1 The Coastal Forest and Thornveld and Eastern Province Thornveld

###### Coast Dune Scrub and Forest (Bc)

This type, north of the Buffalo, is very prominent as the forests seem to be less disturbed than further south. A maximum width is reached at Cape Morgan.

###### Coast Forest (Fv)

Coast Forest was undoubtedly more extensive prior to the arrival of man. These forests are now only remnants, but may be seen along the Kei River and in many small patches along water courses. The grassland in this coast area, if protected, soon reverts to scrub that in turn will develop into forest. This process, however, is not in the interests of farming, where grass is the important fodder. Different land management practices are used to control shrub encroachment, and a wide range of physiognomic types are obvious from the varying hues on the photolithoprint. Many of these coast forests occur only in the protection of steep-sided river valleys.

###### Coastal Thornveld and Eastern Province Thornveld (WG)

Acocks recognizes two main vegetation types on a floristic basis but these two vegetation types are indistinguishable on the satellite imagery, which is understandable as they both appear as wooded grass types. They occur on the interfluvies and reflect biotic variations. The area north of the Buffalo River has a strong red tinge suggesting a generally more dense tree cover.

##### 4.2.2 The Valley Bushveld (VB)

The river valleys of the northern sector of the image have a similar species composition to those in the south, but the valleys may be deeper, in places providing a more suitable habitat for dense mesic vegetation and forest development, and similarly a reduction in the xeric types.

The main line of thorn tree encroachment does not occur on the coastal belt, but in the drier parts where the Great Kei River has provided a corridor for the invasion of Acacia karroo into the grassland areas.

#### 4.2.3 Sweet Veld (Giv)

In the drier valley around Stutterheim is an area with highly palatable grass cover. This area is predominantly grassed but susceptible to invasion by thorn trees if overgrazed as demonstrated by the tongues of the thorn tree element of the valley bushveld which has already invaded part of the valley.

#### 4.2.4 The Dohne Sourveld

This type can again be divided into two components:

##### Midland Forest (F)

Forests cover a considerably smaller area north of the Buffalo River, but are easily recognised by their bright red hue. The forests that grow here have been protected by the individual farmers on whose land they occur.

##### The Grass Phase (Giii)

This is more extensive than in the south and may be recognised by its orangey hue. It is interesting to note how it is at present confined to the main ridges, while the valleys of the tributaries of the Kei provide a passage for invasion of the grass by microphyllous thorn tree elements of the Valley Bushveld. Greyish areas following river valleys towards Stutterheim show the extent of the Valley Bushveld invasion.

#### 4.3 The Area Between the Keiskamma and Fish Rivers

##### 4.3.1 Coastal Belt

##### Coast Dune Scrub and Forest (Bc)

This type is similar to the Coast Dune Scrub and Forest of the other areas described.

##### Coast Belt (WG)

The coast belt has become a wooded, grassed area, although the climax would be forest if the vegetation were left undisturbed. Acocks

(1953) notes that this forest would be of a different type to those described in 1.1.3 and 2.1.2, being more xeric in nature, though this is not evident from the satellite imagery.

#### 4.3.2 Valley Bushveld (VB)

This vegetation type tends to dominate in this sector, where both the Fish and Keiskamma Rivers having extensive valleys.

##### Keiskamma River Valley (VB)

The vegetation appears similar to the other Valley Bushveld areas, with a certain amount of coast forest development in the valleys. In the catchment area a considerable amount of secondary disturbance has taken place denoted by an 's'. It is interesting to note that there appears to be a greater occurrence of forests in the tributaries on the south bank of the river than the north. This may be natural, but it is possible that there is a biotic influence here, with the timber having been used for domestic purposes.

##### The Valleys of the Begha and Gualana (SBV)

The catchment area of these rivers is evident as a particular vegetation type with a succulent Valley Bushveld type (SBV). It may be recognised by its dull red hue, as against the brighter red of the true forests. The light orangey-red patches which occur are the result of agriculture, possibly pineapples, which are a perennial crop and will have a strong reflectivity, even at the beginning of summer when annual crops have not developed.

Nearer the coast, approximately 20 km from the sea, the river valleys narrow and the Bushveld vegetation decreases.

##### The Fish River Valley (SBV)

This particular valley is well known for its succulent bush vegetation, that shows up well on the imagery in the same dark red hue as in the Begha and Gualana River valleys.

The river has cut a steep straight valley for approximately twenty kilometres from the sea, then it enters a broad valley which on the imagery is obvious from its dark grey colour. This dark grey corresponds to a succulent shrub vegetation. However, it is probably the rock type reflectivity which results in this particular photo hue. The hills and side valleys surrounding the major valley support a succulent scrub.

Invasive Valley Bushveld (VB - this type is mixed with the  
Wooded Grassland WGi)

Directly north of the broad Fish River Valley, above the 300 m contour, are two areas which are light grey in colour and which probably represent an area previously grassed and now denuded by management malpractices and invaded by microphyllous Acacia karroo trees and shrubs.

4.3.3 Wooded Grasslands (WGi)

The remaining area may be divided into two different types of wooded grassland. In the west, on the south bank of the Keiskamma River, is a well-covered area with dense vegetation development. In the east, however, forming a semicircle around the Gualana, Begha catchment areas, is a somewhat denuded wooded grassed area.

4.4 Urban Development

The area depicted in this image is the Border Region, centered on the port of East London on the estuary of the Buffalo River.

Urban development associated with East London stretches from the south bank of the Buffalo River to the mouth of the Gonubie River.

Two dams are situated along the Buffalo River to provide water for East London industry and human consumption. The line of rail can be followed from East London towards the interior to Zwelitsha and King Williams Town.

Stutterheim, Berlin and Komga, small market towns, are also recognizable.

5. CONCLUSIONS

1. From an entirely vegetational aspect, ERTS imagery cannot be used to give definite results, but is certainly a useful tool to formulate ideas about the vegetation and to assist considerably in the boundary mapping of pre-investigated areas of sizes approximately 20 000 hectares in extent.
2. This particular image gives a synoptic view of an area, a portion of which has, in the past, been mapped in detail (Board, 1962), and which has been studied briefly by the investigator. This portion acted as truth site information, and from there it was possible to extrapolate certain hue characteristics and interpret them in terms of vegetation.

3. The extrapolation was found to be extremely difficult as the physiognomic variation of most of the area is limited, being of a thorn savanna type with varying degrees of tree and shrub. This resulted in comparatively few categories. However, on a regional basis it is important that this large area, termed 'Wooded Grassland' can be recognised.
4. The locality of the major forests has been known for years, but their boundaries have never been accurately mapped at a regional level. This was done with comparative ease.
5. The boundary between pure, well-managed grass and the savanna types is clear, as in the case of the 'Dohne Sourveld' grass phase and the major savanna types, but the boundaries between grassveld and the thornveld in different circumstances, as in the area west of King Williams Town is somewhat arbitrary.
6. The separation of succulent shrub types and forests due to their different hue saturations is useful and some confidence can be placed on the interpretation.
7. This image highlights the problems of land utilization in the area with the encroachment of Valley Bushveld into mismanaged areas, the difference in management between Bantu areas and European areas being marked.
8. One problem still to be studied in detail is the separation of natural evergreen forest from planted exotic forest plantations; this will be investigated in the next three month period.

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F. AN INVESTIGATION INTO THE MAPPING OF KELP  
BEDS OFF THE WEST COAST OF SOUTH AFRICA  
USING ERTS-1 IMAGERY

Assistant Investigator: N.G. Jarman

1. OBJECTIVES

To determine the extent of Kelp beds, known to exist off the coast (in order to investigate the possibility of harvesting these for industrial purposes), at request of the South African Seaweed Laboratory, Department of Industries.

2. METHOD

Reports concerning the successful completion of a similar project in America (Estes, J.E., 1973) were received.

Relevant coastal imagery (scenes 1055-08064, 1145-08073) using Black and White prints of bands 4, 5, 6 and 7 at 1:1 000 000 and was then in turn examined using various colour combinations in a multi-spectral viewer, at the same scale and with a x3 enlarging lens.

The images of band 6 were then re-processed photographically for maximum tone difference in the sea by increasing the contrast, and were viewed in the multi-spectral viewer.

3. RESULTS

All images examined gave a negative result.

4. CONCLUSIONS

One possibility for failure is that all photos were taken at high tide, which may completely cover the kelp.

Another possible reason for failure is that the photographic quality of the 70 mm imagery utilized is of a slightly inferior quality. Furthermore, there was no groundwork done on this project and possibly failure could be attributed to lack of experience on behalf of the investigator.

5. FUTURE WORK

Enlargements to 1:500 000 will be produced in the near future from 9" originals and will be examined for detection of kelp beds.

ESTES, J.E. 1973; "Use of ERTS-1 data to assess and monitor change in the west side of the San Joaquin valley and central coastal zone of California (UN070)" In "An integrated study of Earth Resources in the State of California based on ERTS-1 and supporting aircraft data". Space Sciences Laboratory, University of California Berkley under (NASA contract 5-21827).

#### IV. GEOLOGIC INTERPRETATION OF ERTS-1 IMAGERY

Co-investigator : Dr W.L. van Wyk

##### A. THE TRANSVAAL

Assistant Investigators : Mr S.B. de Villiers  
Geological Survey  
Prof. W.J. van Biljon  
Rand Afrikaans University  
Johannesburg

##### 1. OBJECTIVES

- (a) To detect lineaments that could be mineralized or cast light on possible petrographic and metallogenic provinces.
- (b) To interpret the complicated fault system of the Zoutpansberg area.

##### 2. RESULTS

###### 2.1 Lineaments

In the area of Archaean granite between Louis Trichardt and Pietersburg three lineaments not previously noted have been recognised on image 1049-07292. A faint lineament striking NE coincides with occurrences of gold and copper at and near the old Harlequin Mine on Goedgenoeg 185 LS, the minor copper occurrences near Bandelierkop, and the phosphate (apatite/vermiculite) deposits NE of Bandelierkop. This lineament may therefore represent a zone of mineralization probably related to a shear or fracture zone although the apatite deposits are associated with pegmatites. A shear zone striking more or less in the same direction has been reported to occur in this apatite-bearing area.

Two lineaments striking NW are probably also fractures or fault zones but as yet no mineralization has been found on them.

A mosaic of ERTS-I photos covering the Transvaal revealed the following: Apart from the fact that major units such as the basic rocks of the Bushveld Complex, the Pilanesberg Alkaline Complex, the general trend of the Transvaal Supergroup, the extent of Ventersdorp lava in the western Transvaal etc. could be recognized, some large scale structural features could be observed. In particular some faults could be seen lying on major lineaments, not recognized before. One such

lineament running for nearly 600 km across the Transvaal begins in Swaziland and runs in a north-westerly direction through the Bushveld Complex into Botswana. It was also noted that the south-western edge of the Barberton Mountainland is bounded by this lineament, that the triangular patch of felsite protruding through Waterberg sandstones has one side parallel to the same lineament and that both the alkaline rocks near Badplaas and the carbonatite at Glenover lie on this line. It was further noted the north-west trending faults in the western Bushveld Complex are continuous for much longer distances than indicated on the geological maps and that a large number of pipe-like bodies (volcanic vents) lie on these lineaments, e.g. carbonatites, at Gondine, Tweerivier, Bulhoekkop, Nootgedacht and Kruidfontein, alkaline rocks at the Vredefort Dome and the Cu-bearing volcanic plug at Roodewal south-east of Potchefstroom.

A number of east-north-east trending lineaments were also noted in the same area. These are not shown on any geological maps except that the fault skirting the southern side of the Pilanesberg is parallel to this direction. The direction also coincide with some kimberlite fissures occurring north of Swartruggens.

It is concluded that many of the geological features of the Transvaal, including sedimentary basins, granite plutons and volcanic plugs are controlled by fundamental crustal fractures which have been active since the earliest geological history and may be active even to the present.

## 2.2 The Zoutpansberg Area

Apart from the recognition of known major faults the only noteworthy observation is that of an E-W fault, with a down-throw side to the north, which can be traced from the Soutpansberg across to the Blouberg. The presence of this fault cannot easily be deduced from ordinary aerial photographs.

On the 1:1 000 000 images the only physical features and geological structures that can be recognised are those in mountainous regions: elsewhere they are very vague and difficult to detect, especially where there are dark patches due to veld fires. The 1:500 000 colour composite enlarged prints, which were available for only three scenes, are very much clearer. The advantage of ERTS images is to show the regional pattern of major features.

### 3. CONCLUSIONS

ERTS-1 images provide a comprehensive view of the major geological units and of structures already known and, in the case of major faults, checking their extension. Such comprehensive views are of value in replacing cumbersome mosaics of ordinary air photos for reconnaissance purposes before mapping and as an aid in structural synthesis after mapping.

The only new observations so far made in the area that are of any apparent consequence are the major lineaments in the Transvaal. A large number of pipe-like bodies (volcanic vents) lie on some of these lineaments.

Provided the required features can be identified, the accuracy of the images is valuable for it enables accurate very small scale maps to be traced from them.

Lineaments are almost entirely restricted to rough or mountainous country. Some have been identified as members of joint systems, others as major faults, a very few as major dykes, but most cannot be identified if they have not already been mapped.

Folds can be recognised only if the strata are highly resistant to erosion.

In some regions tonal or textural differences indicate lithological differences but very rarely can system, series or formation boundaries be located sharply enough for mapping purposes.

### 4. RECOMMENDATIONS

1. Better definition is needed.
2. Enlargements to 1:500 000 should accompany the standard images.
3. Colour composite prints are better than black and white.

### 5. FUTURE STUDY

The regional geologic structure of the Bushveld Igneous Complex will be investigated.

## B. NATAL

Assistant Investigator: Dr J.W. du Preez  
Geological Survey

### 1. OBJECTIVES

The objectives of this investigation included the examination of (a) the regional geological structure of the Lebombo monocline and of the pre-Cambrian rocks in the Nkandla area, (b) lineaments and structures in the Nkandla area with special reference to the possibility of mineralization and (c) large-scale structural features in the Karroo rocks which could be useful in the oil exploration programme now being carried out.

### 2. APPROACH

This activity consisted only of examining visually the ERTS images in the office and comparing the features shown with all existing geological data and maps, particularly with the 1970 Geological Map of South Africa, scale 1:1 000 000. Sometimes a hand lens with small magnification was used. Unfortunately, there was not sufficient time for field checking of any anomalous features on the images that do not appear on current geological maps.

### 3. PROBLEMS

Inadequate photographic definition of the multispectral images hampered geographical identification severely. For instance, the dual carriage freeway between Durban and Mooi River, with an unbroken distance of 150 km, does not show up anywhere on the images, nor has any major city or town been photographically recorded. This poor definition made accurate plotting difficult and cumbersome.

### 4. RESULTS

#### 4.1 Geological structures - Lebombo and Nkandla

The Lebombo monocline, which has already been mapped in great detail by the Geological Survey, is clearly shown on the images as a major structure. Minor displacements are visible and numerous linear features representing multiple fracture-filling are discernable. The area of maximum dolerite invasion to the west of the Hluhluwe-Mkuze axis is shown on 1010-07131. The complex Bumbeni volcanism on the eastern

slope of the Lebombo Range is hardly recognizable, but with better photographic definition this complex assemblage of acid and basic lavas might have been demarcated. The large Tugela fault is shown clearly as a multiple fracture but poor definition prevented detailed structural analysis of the pre-Cambrian rocks in the Nkandla area.

#### 4.2 Lineaments and Structures in Relation to Mineralization

Poor photographic definition excluded accurate identification of structures on the images in the Nkandla area. Between Pongola and Piet Retief a series of parallel lineaments is, however, clearly shown, which probably represents a swarm of diabase dykes vide Geological Sheet No. 68 (Piet Retief). In addition, image 1047-07191 shows a lineament, some 80 km long, running NW-SE between Paulpietersburg and Piet Retief. This prominent feature has not been recorded on Sheet 68 (Piet Retief) and therefore warrants close examination on the ground. Although no mineralization is known to be associated with the swarms of basic dykes illustrated on Sheet 68, a re-examination of this possibility appears justified.

#### 4.3 Large-Scale Structural Features in the Karroo System

A light-coloured zone striking roughly NW-SE occurs on image 1047-07191 in the test area some 15 km south of Vryheid. It is known, vide Geological Sheet 102 (Vryheid) that this area is underlain by the Eccia Series of the Karroo System. It is also known that indications of oil occur in the Middle Stage of this Series in the Dannhauser area. Whether the light tone demarcating this zone is due to erosion and down-cutting by the Buffalo River and infilling during Quarternary times remains to be determined. Apart from this area, no other structures which could be useful in the oil exploration programme have been identified in the test area. This is perhaps due to the poor photographic definition of the images.

### 5. CONCLUSIONS

Examination of the multi-spectral images has shown that only major structural features and lineaments can be identified in the test area. In general, these data corroborate known mapping results as known on published maps, but in the northern part of the test area a lineament of some 80 km in length is indicated, which has no equivalent on the published sheets. It is considered that more detail will become

identifiable if the photographic definition of the images could be improved. As they are, few geographical details such as rivers, roads, railways, cities and towns are visible on the images and this makes it difficult to accurately locate specific positions in the test area.

#### 6. RECOMMENDATIONS

It is recommended that every effort should be made to improve the photographic definition of the images in order to facilitate identification of greater structural details and also to facilitate the location of specific geographical positions.

#### 7. FUTURE STUDY

The objectives outlined in the preface have not yet been fully attained, though some progress has been made. It is envisaged that when images with better definition become available and after certain visits to critical areas have been made, rapid progress might be possible.

## V. EVALUATION OF ERTS-1 IMAGERY IN LAND USE SURVEYS

Co-investigator : Mr L. Claassen

Assistant Investigator: Mr J.G. van Zyl  
Department of Planning and  
the Environment

### 1. LAND USE SURVEY

From the study of ERTS-A imagery the Department has come to the conclusion that the greatest advantage which can be derived from the imagery is by undertaking land use analyses on a macro-scale, which can be useful mainly in the field of regional planning. In order to assist the Department in the evaluation of imagery, with regard to land use over the country as a whole, it has been decided to get those universities who are interested to participate in this type of research.

### 2. SOUTH AFRICAN UNIVERSITIES PARTICIPATION IN THE DEPARTMENTS ERTS-1 RESEARCH PROGRAMME

The University of Cape Town and the University of Stellenbosch are interested in the area south of 32°S and west of 23°E in the Southern Cape, while the University of South Africa, the University of the Witwatersrand, the Rand Afrikaans University and the University of Potchefstroom are interested in different regions in the Transvaal, mainly the urbanised Pretoria-Witwatersrand-Region and the Bantu Homelands north of Pretoria, the rural areas of the western Transvaal and the Kruger National Park in the Eastern Transvaal Lowveld.

ERTS-1 images have already been sent to the abovementioned universities and as soon as the research results are received they will be incorporated into further reports.

### 3. PRELIMINARY REPORT ON ERTS-A IMAGERY BY THE NATAL PROVINCIAL ADMINISTRATION

In response to a circular sent out by the Principal Investigator the Natal Provincial Administration has submitted preliminary comments regarding certain ERTS-1 images based on direct visual interpretation and limited comparison with existing mapped land use records. No optical apparatus has been used in this preliminary research.

### 3.1 False-colour Lithographic Print 1084-07265-4, 5 & 7 (Ciskei) at 1:500 000

This sheet was compared visually with map sheet Queenstown SE 33/26 in the South Africa 1:500 000 topographical series, which is compiled on the Lambert Conformal Conic Projection with standard parallels at  $24^{\circ}$  and  $32^{\circ}$ .

#### 3.1.1 Latitude and Longitude

It was not found possible to reconcile latitude and longitude graticules on the map with edge markings on the print. Taking as index mark "-" which accompanies the latitude or longitude references along the edges of the scene, we found a consistent shift of approx. 2 km east in longitude and approx. 6 km south in latitude.

#### 3.1.2 Scale

At first there appeared to be scale changes but, after taking the latitude and longitude shift into account, these proved to be negligible.

#### 3.1.3 Features

Water features, natural relief and vegetational variations show up well. Line features are almost totally absent except for rivers, coastline and what appears to be a system of geological structure lines running inland from the Qhoha River valley across the valley of the Great Kei River in roughly an East-West direction. Printing with finer screen might improve the resolution capabilities and enable more detail to be identified.

#### 3.1.4 General

We did not attempt further analysis because we have no land use information available for the area depicted, nor have we yet gained sufficient experience in false colour interpretation to enable us to extrapolate.

### 3.2 Black and White Prints at 1:1 000 000

#### 3.2.1 Land Use Interpretation

In a visual comparison of prints from scenes 1047-07193 (4, 5, 6, 7) and 1047-07200 (5, 6, 7) twelve types of features were identified. Their broad tonal characteristics are given in the table below.

Feature	MSS4	MSS5	MSS6	MSS7
Relief	Good degree of contrast throughout			
Sea	D	D	D	D
Inland water	M	M	D	D
Forest	D	D	M	M
Sugar cane	M	M	L	L
Veld	M-D	M	M	M
Beaches	W	W	D	D
Towns	M	M	M	M
Roads	-	-	M	D
Airport runway (?)	-	-	M	D
Unidentified scattered spots	D	D	L	W
Unidentified patches	D	D	D	D
Unidentified patches (possibly burnt veld)	B	B	B	B

Key to symbols: W = White  
 L = Light  
 M = Medium tone  
 D = Dark  
 B = Black  
 - = Not discernable

## VI. CARTOGRAPHIC QUALITY

Co-investigator: Mr W. Kirchhoff  
Aircraft Operating Co. (Pty) Ltd  
Johannesburg

### 1. OBJECTIVE

To establish the cartographic quality of system corrected MSS imagery.

### 2. METHOD

The 1:500 000 false colour copies of scenes 1049-07295 and 1085-07303, which were scaled according to the nominal cross track registration separation on page 3-5 of the ERTS Data Users Handbook, were analysed.

By identifying 9 points of detail on each ERTS image and on up to date Trigonometrical Survey 1:50 000 topographical series maps, the South African Coordinate System coordinates of these points were obtained.

By comparing 'calculated' distances i.e. coordinate 'joins' with scaled lengths from the photos, 6 scale factors could be obtained between the outer points on each image.

Having the coordinates for the detail points, the South African Coordinate Grid could be superimposed on the images by plotting the intercepts from the detail points. See Figs. 3 and 4, reduced from the originals.

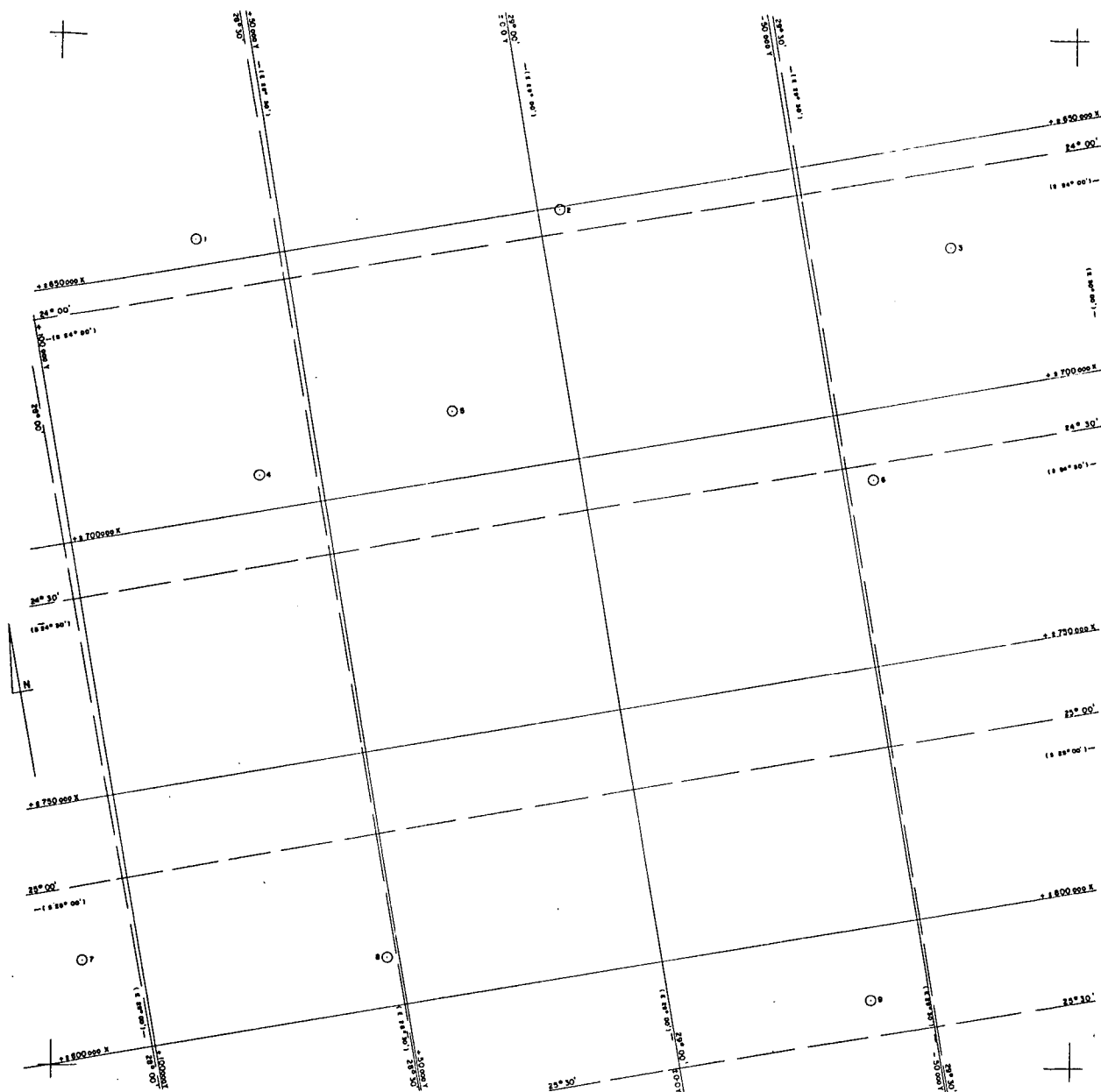
### 3. RESULTS

The mean of the six scale values were respectively 1:502 300 and 1:502 100 for images 1049-07295 and 1085-07303.

It was found that the overlay grid is square to within normal scaling errors and that the expected oblique stereographic projection of the photos transforms with undetectable distortion into the orthomorphic South African Transverse Mercator Projection.

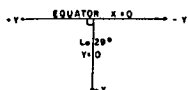
The geographic tick marks supplied by NASA on these system corrected MSS images, prove to be in error with up to 5 km shift in latitude and 3,5 km in longitude, including an azimuthal swing of about 2 degrees.

This study has shown that scaling factors and geographical graticules can be produced by conversion of the coordinate points, which will allow identification of position to within  $\pm 500$  m accuracy, approaching the measurable resolution of  $\pm 250$  m at this scale.



GRID OVERLAY FOR "ERTS" PHOTO  
E-1049-07295 10 SEPT 72

SOUTH AFRICAN CO-ORDINATE SYSTEM  
TRANSVERSE MERCATOR PROJECTION GRID  
CENTRAL MERIDIAN L. 29° EAST



CO-ORDINATES L. 20° METRES

1	2	3	4	5	6	7	8	9
+ 06 954	- 4 115	- 77 937	+ 62 179	+ 22 707	- 35 280	+ 111 403	+ 52 517	- 25 496
+ 2 644 878	+ 2 850 791	+ 2 670 877	+ 2 692 731	+ 2 696 635	+ 2 713 004	+ 2 781 275	+ 2 790 832	- 2 814 453

SCALES

1 - 3	1:502 400
3 - 9	1:501 800
7 - 9	1:501 800
7 - 1	1:503 300
1 - 9	1:503 000
7 - 3	1:501 800

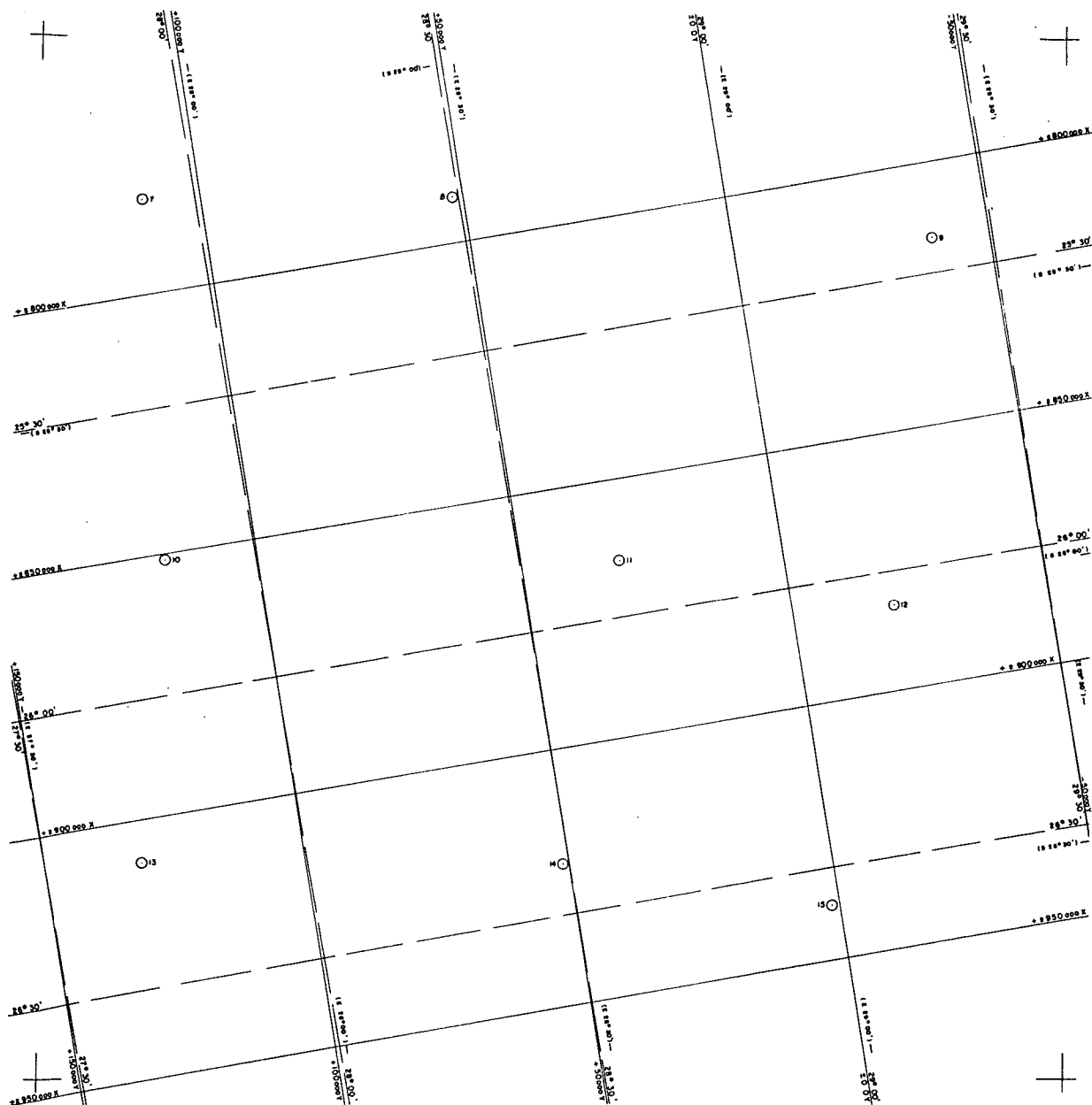
PROJECTION GRID OVERLAY POSITIONED  
FROM IDENTIFIED AND CO-ORDINATED  
DETAIL  
GEOGRAPHICALS FROM GRID CONVERSIONS  
BY:-

AIRCRAFT OPERATING CO (PTY) LTD.

AUGUST 1973

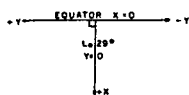
*W. Kiehlhoff*  
LAND SURVEYOR

FIG.3



GRID OVERLAY FOR "ERTS" PHOTO  
E-1085-07303 16 OCT 72

SOUTH AFRICAN CO-ORDINATE SYSTEM  
TRANSVERSE MERCATOR PROJECTION GRID  
CENTRAL MERIDIAN  $L_0$  29° EAST



CO-ORDINATES  $L_0$  20° METRES

	Y	X
7	+ 111 403	+ 2 781 275
8	+ 52 517	+ 2 790 832
9	- 38 496	+ 2 814 490
10	+ 117 499	+ 2 831 196
11	+ 31 242	+ 2 855 734
12	- 19 558	+ 2 883 585
13	+ 131 485	+ 2 908 575
14	+ 51 541	+ 2 922 549
15	+ 1 825	+ 2 938 146

SCALES

7 - 9	1:504 400
9 - 15	1:500 000
15 - 13	1:502 100
13 - 7	1:502 030
7 - 15	1:503 800
13 - 9	1:500 300

PROJECTION GRID OVERLAY POSITIONED  
FROM IDENTIFIED AND CO-ORDINATED  
DETAIL.  
GEOGRAPHICALS FROM GRID CONVERSIONS  
BY:-

AIRCRAFT OPERATING CO (PTY) LTD.

AUGUST 1973

*D. K. Hoff*  
LAND SURVEYOR.

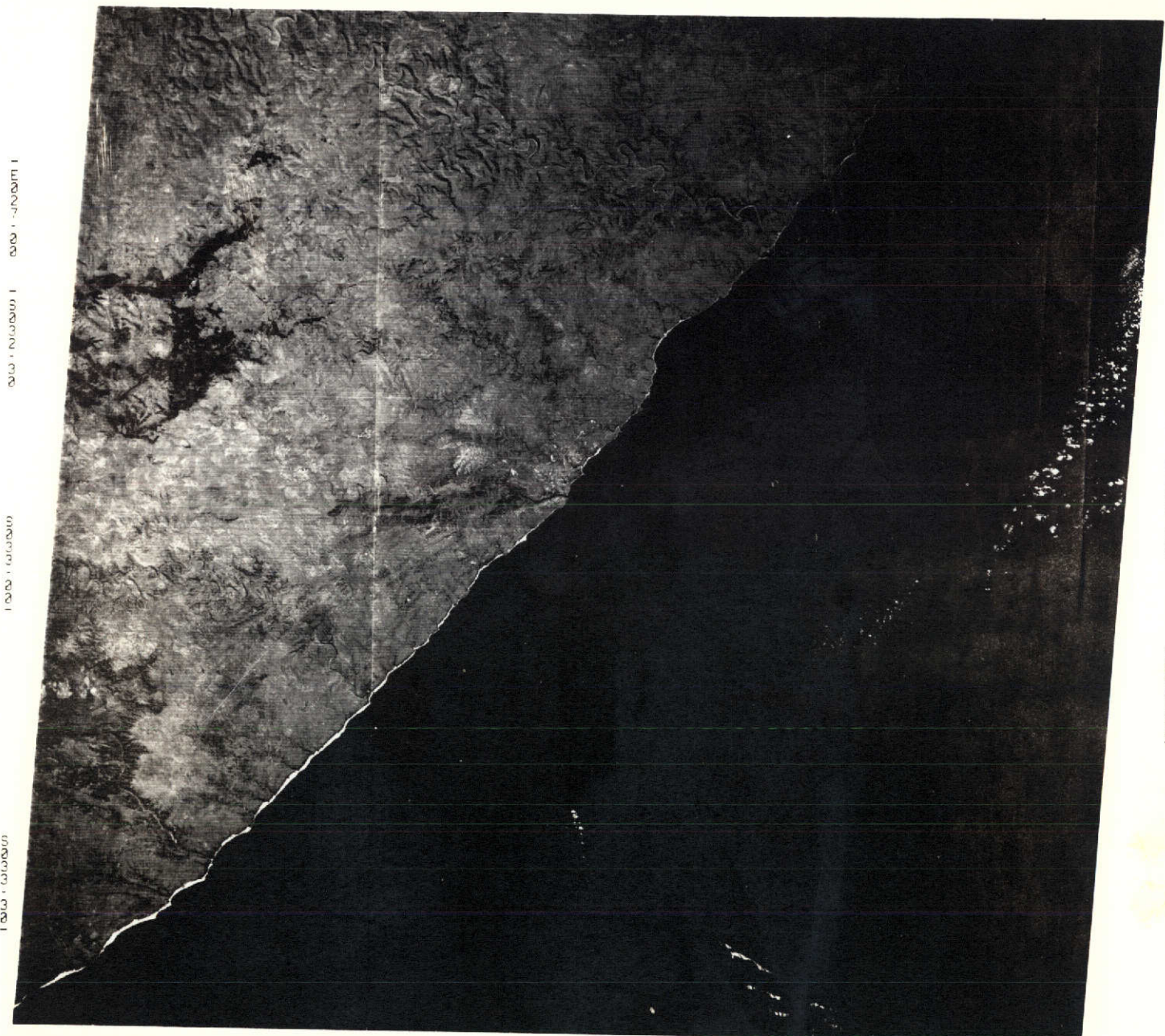
FIG.4

5

E027-30

E028-00

E028-30

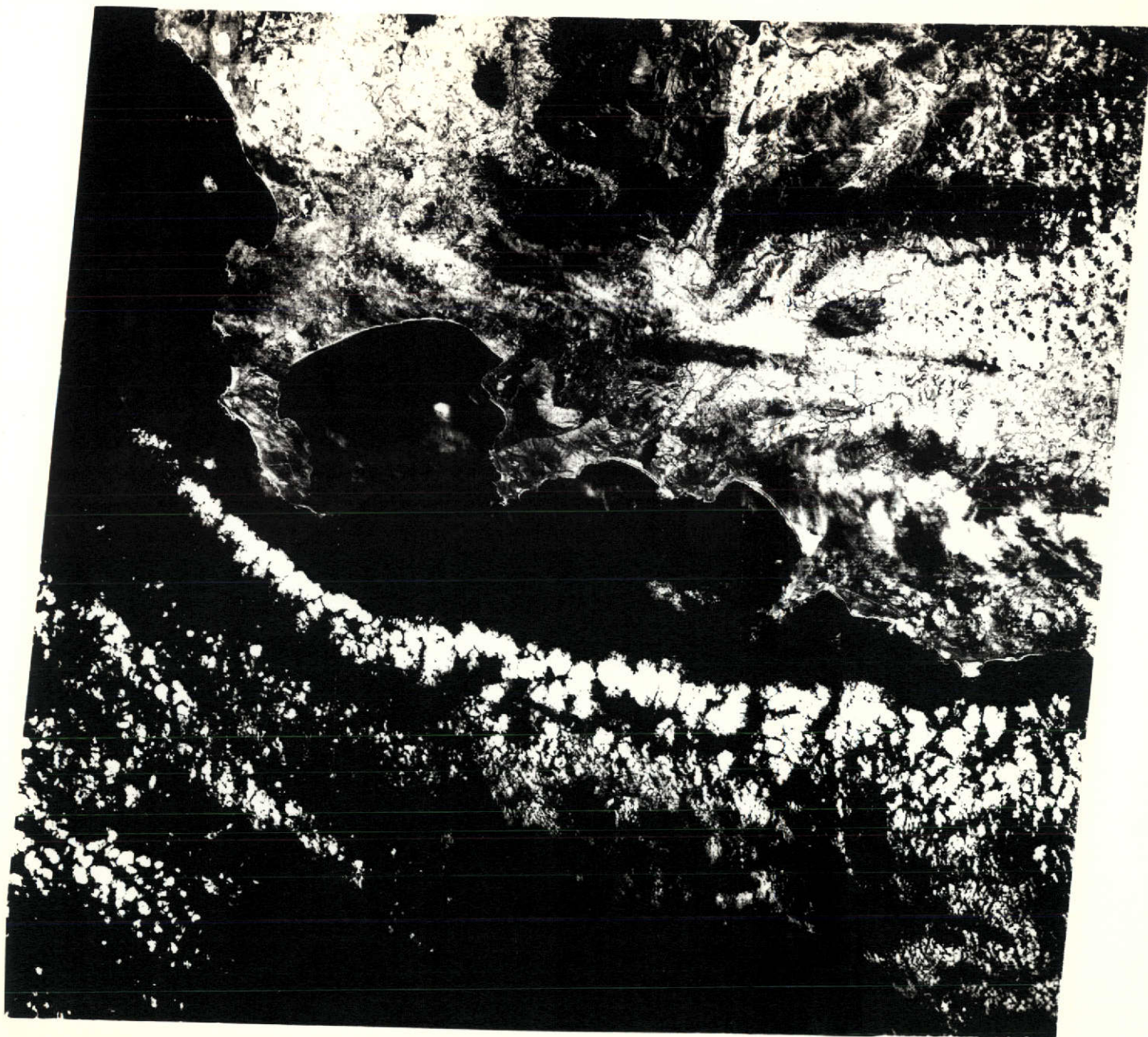


E027-00 E027-30 E028-00 E028-30  
1500172 0 933-01/E027-57 N 933-03/E028-04 MSS R SUN EL48 AZ062 190-1165-A-I-N-D-2L NASA ERTS E-1084-07265-5 01

E018-301 1S033-30

E019-001

E019-301

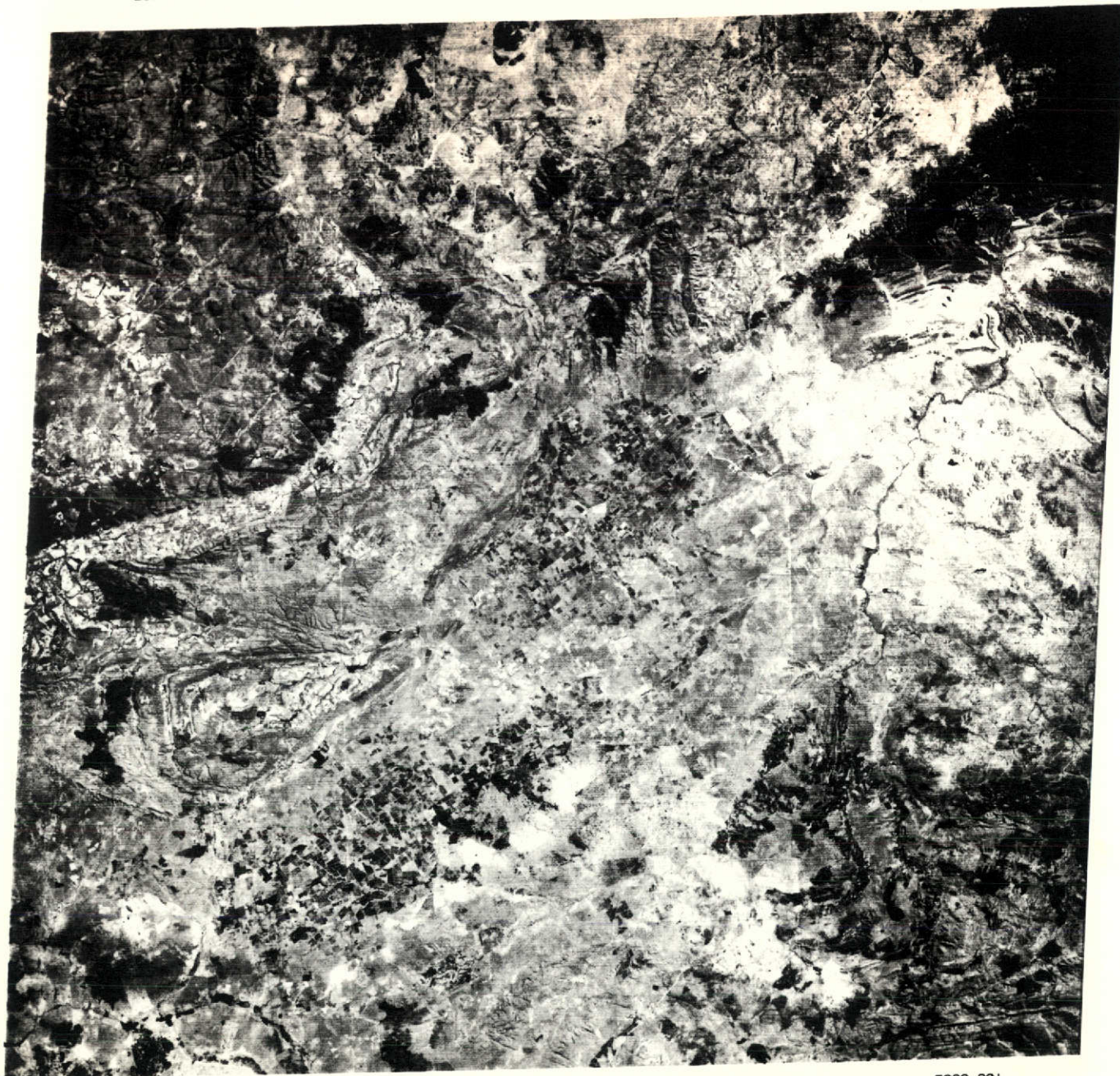


19JAN73 C S34-25/E018-54 N S34-28/E019-04 MSS 5 R SUN EL49 AZ001 E018-001 E019-001 E019-301  
189-2504-A-I-N-D-ZL NASA ERTS E-1100-00015-5 01

E028-301

E029-001

E029-301



E028-00 E028-301 E029-001 E029-301  
10SEP72 C S24-31/E028-57 N S24-33/E029-02 MSS 5 R SUN EL42 AZ056 189-0677-A-I-N-D-2L NASA ERTS E-1049-07295-5 02